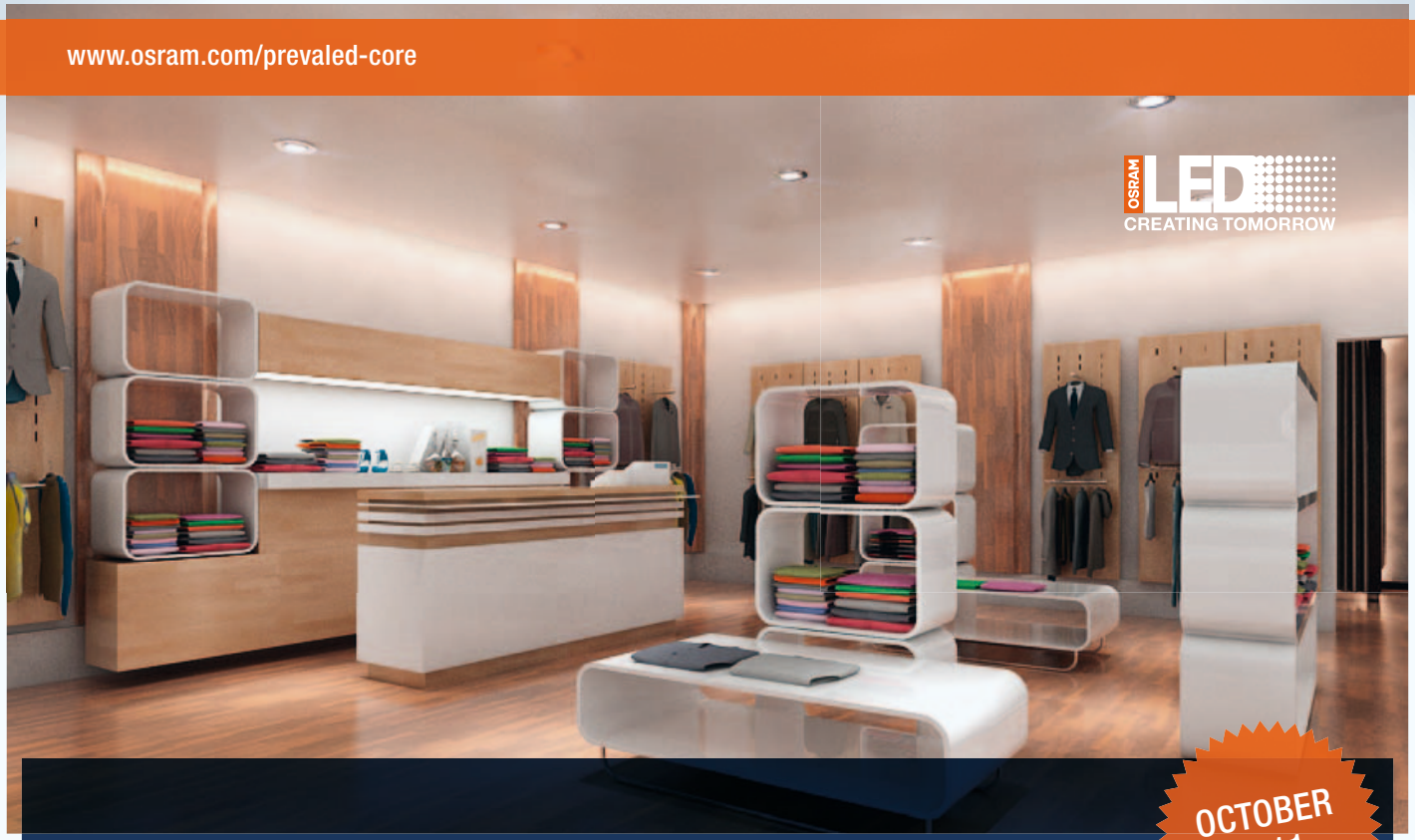
www.osram.com/prevaled-core



OCTOBER 2011

Application guide.

PrevaLED® Core light engines.

OSRAM

Please note:
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Please check *www.osram.com/prevaled-core* or contact your sales partner for an updated copy of this guide.

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1. Introduction

1.1. System overview

Brightness levels of today's LEDs are opening the door for usage of LEDs in general lighting applications requiring high lumen output levels. Building an LED-based luminaire poses a new set of technical challenges, among them new optical requirements, providing adequate thermal management for stable operation and lastly dealing with the ever-improving performance of LEDs.

OSRAM's PrevaLED® family of LED light engines addresses the challenges of LED-based lighting while at the same time providing great performance and flexibility to the user.

The PrevaLED® Core series of light engines is ideally suited for use in reflector-based, rotational symmetrical applications such as downlights or spotlights. These light engines provide several convincing benefits in the application:

- PrevaLED® Core light engines are available as a system of matching light engines and ECGs and deliver maximum performance at very high levels of efficiency.
- The light engines provide superior optical performance, both in optical efficiency as well as high quality of light (color rendering).
- The wide range of lumen packages (currently available from 800–3000 lm) allows addressing a wide range of applications based on a single platform of light engines, all delivering the same quality of light and performance. It is, for example, possible to create a range of spotlights, ranging from halogen-class up to HID levels, all with the same optical characteristics, delivering a consistent experience for the end user.
- Thanks to high thermal and optical performance, luminaires based on PrevaLED® Core light engines can be realized with minimized size of required heat sink and reflector, giving a greater design flexibility to the user.
- PrevaLED® Core light engines provide stable interfaces for the user, in particular by defining stable lumen packages over time. Independent of future increases in LED efficacy, the lumen output of a given type of light engine will remain constant, but at lower power consumption. In this way, a luminaire designed on the PrevaLED® Core platform will automatically benefit from efficacy improvements without needing a lengthy and costly redesign of the base construction.

Movable 3D PrevaLED Core ECO Z2 (works with Adobe Acrobat 7 or higher)

PrevaLED® Core light engines are available in different performance grades, namely lumen output and color rendering. At present, the available systems are:

- Lumen packages of 800–3000 lm are available with a high-quality color rendering (HD light engines – see nomenclature – with CRI > 90/85). Due to internal construction with a high-dynamic optical control of color point, these light engines provide exceptional stability of color temperature and module-to-module consistency.
- For basic applications, the lumen packages of 800–3000 lm are also available in CRI 80. These light engines employ a modified housing construction leading to a better efficacy of the light engine.

The PrevaLED® system consists of an LED light engine, dedicated OTp and connecting cable.

Besides providing superior quality of light, the HD-type light engines also outperform typical modules based on single-phosphor white LEDs. The efficacy of the light engines not only results in minimized energy consumption of the luminaire, but also reduces the thermal load on the luminaire, allowing for smaller and lighter designs of the heat sink.

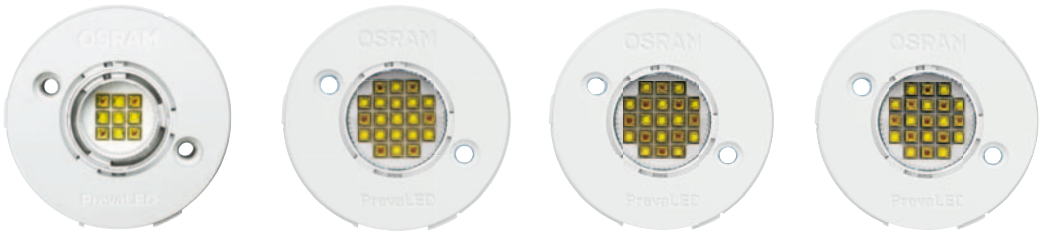
All HD types are available in 3000 K and 4000 K CCT. The CRI 80 (Z2) types are available in flux packages of 800 lm, 1500 lm, 2000 lm and 3000 lm in color temperatures of 2700 K, 3000 K, 3500 K and 4000 K.

PrevaLED® Core light engines must be operated with OPTOTRONIC® power supplies of the “OTp” type. Available types and valid system configurations are detailed in the next section.

Additional details on optical, thermal, mechanical and electrical characteristics can be found in the following sections. Additional and updated information (as well as updates of this guide) will be posted at *www.osram.com/prevaled-core*.

OSRAM also provides an extensive range of energy-saving light management components, such as sensors and room controllers. By use of these products, additional energy savings can be realized. For an overview of these products, please visit *www.osram.com/lms*.

PrevaLED® Core HD: Four lumen stacks



800 lm *1500 lm* *2100 lm* *3000 lm*

	800 lm	1500 lm	2100 lm	3000 lm
3000 K	LEP-800-930-HD-C	LEP-1500-930-HD-C	LEP-2100-930-HD-C	LEP-3000-930-HD-C
4000 K	LEP-800-840-HD-C	LEP-1500-840-HD-C	LEP-2100-840-HD-C	LEP-3000-840-HD-C

PrevaLED® Core ECO Z2: Four lumen stacks

800 lm *1500 lm* *2000 lm* *3000 lm*

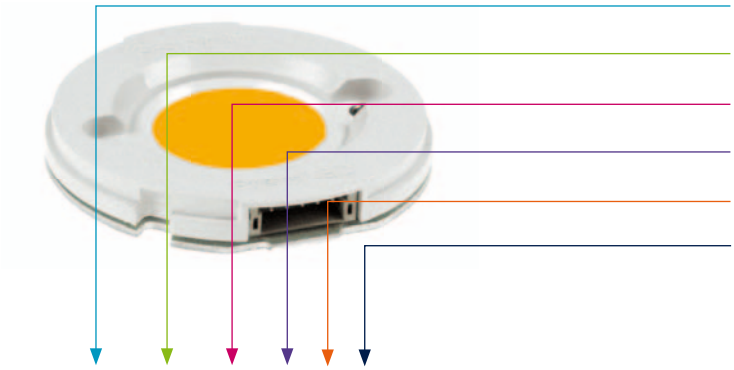
	800 lm	1500 lm	2000 lm	3000 lm
2700 K	LEP-800-827-C-Z2	LEP-1500-827-C-Z2	LEP-2000-827-C-Z2	LEP-3000-827-C-Z2
3000 K	LEP-800-830-C-Z2	LEP-1500-830-C-Z2	LEP-2000-830-C-Z2	LEP-3000-830-C-Z2
3500 K	LEP-800-835-C-Z2	LEP-1500-835-C-Z2	LEP-2000-835-C-Z2	LEP-3000-835-C-Z2
4000 K	LEP-800-840-C-Z2	LEP-1500-840-C-Z2	LEP-2000-840-C-Z2	LEP-3000-840-C-Z2
	Further lm stacks of 4000 lm and 5000 lm will be available in 2012.			

1.2. System information

1.2.1. Nomenclature and marking

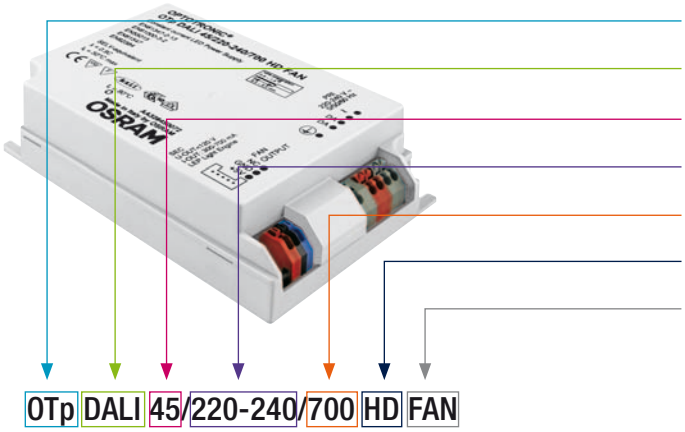
The PrevaLED® family follows a consistent naming convention for identifying key parameters of the light engine and the power supply. The nomenclature of light engines and OPTOTRONIC® ECGs is as follows:

Light engine:



LEP = Light engine PrevaLED®
3000 = 3000 lm
930 = CRI + CCT = CRI > 90 + 3000 K
HD = High Dynamic*
C = Core, round shape
Z2 = Product generation Z2 (if applicable)

Power supply:



OTp: OPTOTRONIC® PrevaLED®
Control protocol: DALI (if applicable)
Wattage: 45 W
Input voltage range: 220–240 V
Maximum output current: 700 mA
HD = High Dynamic*
FAN = connector/auxiliary output

** If HD is not noted, the light engine is an ECO type.*

1.2.2. Technical data

All values regarding system efficiency and system power consumption include the complete system and are based on T_c maximum:

Light engine (at T_c max) + *Power supply (at T_c max)*

All values regarding light engine efficiency and light engine power are based on T_c maximum.

PrevaLED® Core HD

Technical data product family PrevaLED® Core

Light engine	System/ light engine Power [W]	Luminous flux [lm]	System/ light engine Efficacy [lm/W]	CCT [K]	CRI	Viewing angle [°]	Initial SDCM	Lifetime L70/B50 at T_c max. [h]	T_c max [°C]
PrevaLED® Core HD									
LEP-3000-930-HD-C	43/39	3,000	70/77	3,000	>90	>130	<3	50,000	60
LEP-3000-840-HD-C	43/39	3,000	70/77	4,000	>85	>130	<3	50,000	65
LEP-2100-930-HD-C	28/25	2,100	75/84	3,000	>90	>130	<3	50,000	65
LEP-2100-840-HD-C	28/25	2,100	75/84	4,000	>85	>130	<3	50,000	65
LEP-1500-930-HD-C	16/19	1,500	75/84	3,000	>90	>130	<3	50,000	65
LEP-1500-840-HD-C	16/19	1,500	75/84	4,000	>85	>130	<3	50,000	65
LEP-800-930-HD-C	11/9	800	75/88	3,000	>90	>130	<3	50,000	65
LEP-800-840-HD-C	11/9	800	75/88	4,000	>85	>130	<3	50,000	65

PrevaLED® Core ECO Z2

Light engine	System/ light engine Power [W]	Luminous flux [lm]	System/ light engine Efficacy [lm/W]	CCT [K]	CRI	Viewing angle [°]	Initial SDCM	Lifetime L70/B50 at T_c max. [h]	T_c max [°C]
PrevaLED® Core ECO Z2									
LEP-3000-827-C-Z2	36/31	3,000	84/97	2,700	80	>120	<4	50,000	65
LEP-3000-830-C-Z2	33/29	3,000	90/104	3,000	80	>120	<4	50,000	65
LEP-3000-835-C-Z2	32/29	3,000	93/107	3,500	80	>120	<4	50,000	65
LEP-3000-840-C-Z2	32/28	3,000	94/108	4,000	80	>120	<4	50,000	65
LEP-2000-827-C-Z2	32/28	2,000	62/72	2,700	80	>120	<4	50,000	65
LEP-2000-830-C-Z2	29/25	2,000	68/79	3,000	80	>120	<4	50,000	65
LEP-2000-835-C-Z2	29/25	2,000	70/81	3,500	80	>120	<4	50,000	65
LEP-2000-840-C-Z2	28/24	2,000	71/82	4,000	80	>120	<4	50,000	65
LEP-1500-827-C-Z2	22/19	1,500	67/80	2,700	80	>120	<4	50,000	65
LEP-1500-830-C-Z2	21/17	1,500	73/87	3,000	80	>120	<4	50,000	65
LEP-1500-835-C-Z2	20/17	1,500	74/89	3,500	80	>120	<4	50,000	65
LEP-1500-840-C-Z2	20/17	1,500	75/90	4,000	80	>120	<4	50,000	65
LEP-800-827-C-Z2	12/10	800	65/79	2,700	80	>120	<4	50,000	65
LEP-800-830-C-Z2	12/10	800	65/79	3,000	80	>120	<4	50,000	65
LEP-800-835-C-Z2	12/10	800	65/79	3,500	80	>120	<4	50,000	65
LEP-800-840-C-Z2	12/10	800	69/84	4,000	80	>120	<4	50,000	65

ECG (OTPOTRONIC®)

Technical data ECG

ECG	Nominal power [W]	Con-trol	Auxiliary output [V/W]	T_a [°C]	T_c max [°C]	Lifetime L70/B50 at T_c max. [h]	Dimensions [mm]		
							Length	Width	Height
OTp DALI 45/220-240/700 HD FAN (*)	45	DALI	5/1	-20…50	80	50,000	123	79	33
OTp 45/220-240/700 HD FAN (*)	45	–	5/1	-20…50	75	50,000	123	79	33
OTp 45/220-240/700 HD (*)	45	–	–	-20…50	80	50,000	123	79	33
OTp DALI 35/220-240/700 HD (*)	35	DALI	–	-20…50	80	50,000	123	79	33
OTp 35/220-240/700 HD (*)	35	–	–	-20…50	75	50,000	123	79	33
OTp 35/220-240/700 (*)	35	–	–	-20…50	80	50,000	123	79	33
OTp 15/220-240/700 HD (*)	15	–	–	-20…50	75	50,000	109	50	35

Cable clamp kit for strain relief available, see *1.2.4. Accessories (page 13)*.
(*) Target values

1.2.3. System combinations

Within rated power, light engines and power supplies can be flexibly combined, e. g. according to desired control option or form factor. Valid and possible combinations of light engines and ECGs are listed below, a general requirement is that HD light engines require the use of “HD” ECGs and that each light engine is connected by a single ECG.

The connection between light engine and ECG should be established by supplied cable kit. Available in lengths 40 cm and 80 cm, please also refer to: *3.2. Wiring information*.

All ECGs utilize well-established housing form factors to facilitate adoption of existing luminaire housings or accessories to the PrevaLED® technology.

Compatibility chart PrevaLED® light engine – ECG

	OTp DALI 45 HD Fan	OTp 45 HD Fan	OTp 45 HD	OTp DALI 35 HD	OTp 35 HD	OTp 35	OTp 15 HD
PrevaLED® Core HD							
LEP-3000-xxx-HD-C	●	●	●	x	x	x	x
LEP-2100-xxx-HD-C	○	○	○	●	●	x	x
LEP-1500-xxx-HD-C	○	○	○	●	●	x	x
LEP-800-xxx-HD-C	○	○	○	○	○	x	●
PrevaLED® Core ECO Z2							
LEP-3000-8xx-C-Z2	●	●	●	x	x	x	x
LEP-2000-8xx-C-Z2	●	●	●	●	●	●	x
LEP-1500-8xx-C-Z2	●	●	●	●	●	●	x
LEP-800-8xx-C-Z2	○	○	○	●	●	○	○
(*) Under development							

● Recommended
○ Suitable
x Not possible

ECG and light engines operate 1:1

1.2.4. Accessories

LEP-PreMix
The PreMix offers an optimized light homogeneity for reflector-based applications such as downlights and spotlights.

Benefits:
- Reduces color fringing and multiple shadows
- Snap mounting in light engine locking ring
- For use with 800–3000 lm light engines
- Additional protection of the light engine against touching

Technical features:
- Diffuse interior and structured outer surface for optimized light homogeneity
- Durable glass construction
- Min. transmission 85 %
- Compatible with PrevaLED® Core HD: LEP-800, LEP-1500, LEP-2000 and LEP-3000
- No impact on the lifetime of the light engine

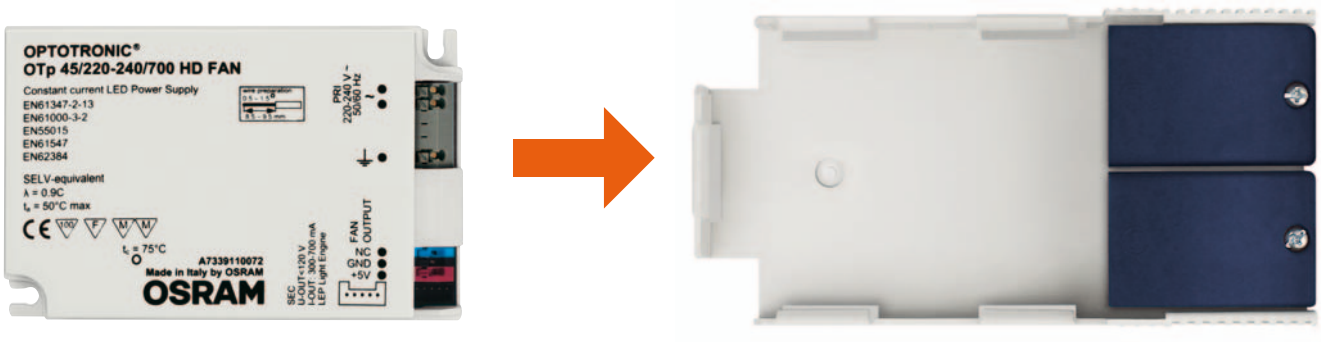
Cable kit
The cable is required for contacting and connecting the individual PrevaLED® Core light engine with the power supply. Two various flexible and reverse polarity protected cable kits are available (cable kit for PrevaLED® Core HD and the PrevaLED® Core ECO Z2 version with a lower connector).

PrevaLED® Core HD cable kit

PrevaLED® Core ECO Z2 cable kit

Cable clamp for OTp

This cable clamp gives the ECG a strain relief and turns it into an ECG suitable for independent installation. It is available for order for all OPTOTRONIC® OTp 35 and OTp 45.



2. Optical considerations

Comparison of LED array and chip-on-board (CoB) designs
PrevaLED® Core light engines can be designed in two different ways: either as LED arrays or as chip-on-board (CoB) technology.

PrevaLED® Core HD

PrevaLED® Core ECO Z2

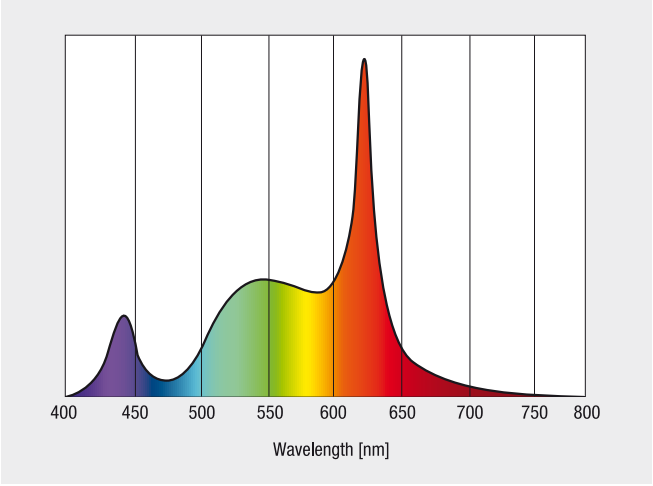
When designed as LED arrays, PrevaLED® Core light engines consist of several high-power LED packages covered with phosphor and arranged in a certain pattern (cf. the images above). The key advantage of this design is the large beam angle: >130° FWHM.

The CoB design is characterized by various single low-power LED chips, arranged in a certain grid which is covered with phosphor (cf. the image above). The key advantage of this design is that it provides a very homogeneous light distribution.

Good red color rendering (R9) and high LED efficiency are usually contrary targets because generating red light out of a blue wavelength generates maximum losses.

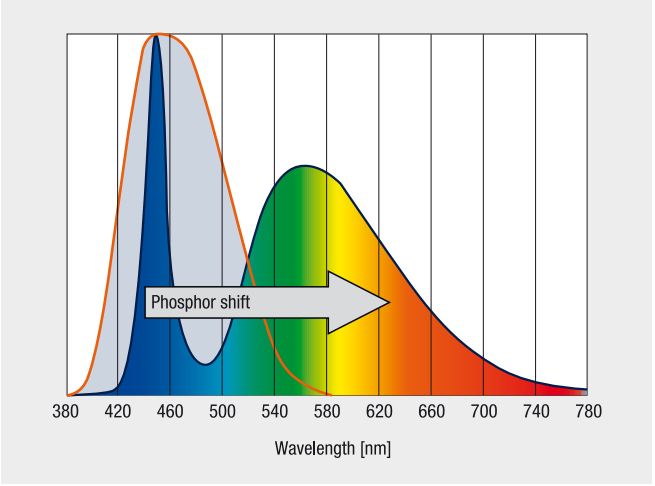
HD concept

With the HD concept, efficient red light from direct red-emitting LEDs is mixed with efficient, greenish white. In this way, PrevaLED® Core HD light engines provide very high CRI (>90) with excellent R9 and the highest levels of efficiency.

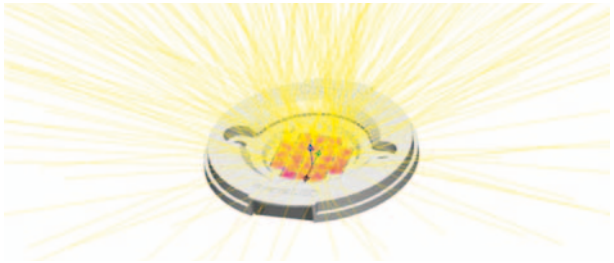


Pure phosphor conversion on CoB

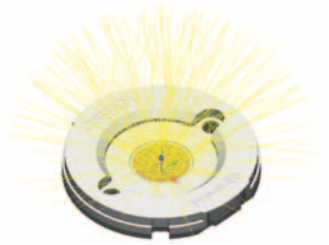
Using the pure phosphor conversion with PrevaLED® Core ECO Z2, color rendering quality higher than CRI 80 can be achieved while providing a very homogeneous light output.



2.1. Reflector



PrevaLED® Core HD



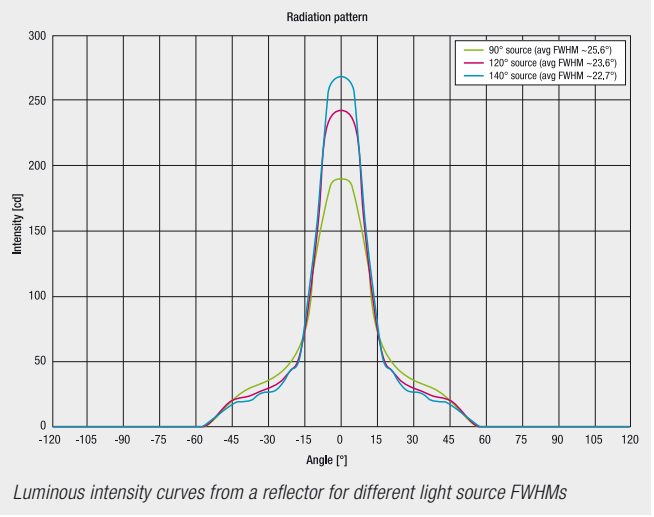
PrevaLED® Core ECO Z2

PrevaLED® Core light engines are ideally suited for use with reflectors. The HD version of the light engines emit light at >130° FWHM (full-width, half-maximum) exceeding the FWHM of Lambertian emitters (120°) which allows shaping and controlling the emitted light more effectively while at the same time minimizing the size of the required reflector.

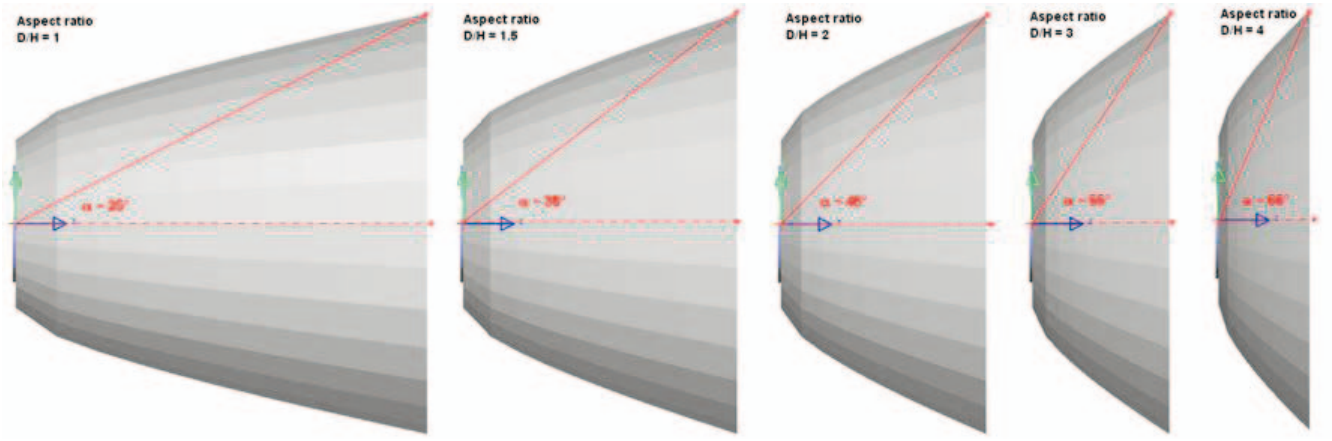
An even light emitting surface due to CoB technology of PrevaLED® Core ECO Z2 with great homogeneity eliminates the need to use diffuser material. A smaller light emitting surface (LES) and a reflector positioning closer to LES enables a better optical handling. A beam angle of 10° or even less is possible with PrevaLED® Core ECO Z2.

Futhermore, this wide emission also maximizes the luminous intensity that is achieved from a given reflector design, as illustrated on the right.

The illustration below shows that an increasing FWHM significantly reduces the required height of the reflector needed for efficient beam shaping. A reduced reflector height can either be used to decrease the overall luminaire height or to improve the thermal performance of the luminaire by increasing the available height for the heat sink.



Luminous intensity curves from a reflector for different light source FWHMs



2.1.1. Reflector design

OSRAM provides mechanical (3D files) and optical simulation data (ray files) to support customized reflector designs. These data are available upon request through your sales partner and for public download at: *www.osram.com/prevaled-core*.

In addition, reflector design support and off-the-shelf components are, for example, available through the following manufacturers:

ACL-Lichttechnik GmbH

+49 2173 9753 0
info@reflektor.com
www.reflektor.com

Alux-Luxar GmbH & Co. KG

+49 2173 279 0
sales@alux-luxar.de
www.alux.de

Jordan Reflektoren GmbH & Co. KG

+49 202 60720
info@jordan-reflektoren.de
www.jordan-reflektoren.de

For PrevaLED® Core ECO Z2 reflector 5020 KFAC (ACL, 71.5 mm diameter, 2x8.53° beam angle) and 113309010101 (Jordan, 108 mm diameter, 2x23° beam angle) can be suggested.

Additional diffusing material may be used to optimize homogeneity within the application, the best efficiency is achieved by placing diffusing material on top of the reflector. Diffusing materials may be chosen according to the luminaire‘s design.

In reference designs, the use of Evonik material Plexiglas® 0D010df with a thickness of 2 mm and with a transmission of 89.6 % resulted in a good performance. Other materials can of course also be used, such as Altuglas 145.10000, for example.

Further support for any Plexiglas® material is available at *www.ledlightforyou.com* or, for example, through the following contacts:

Evonik Roehm GmbH

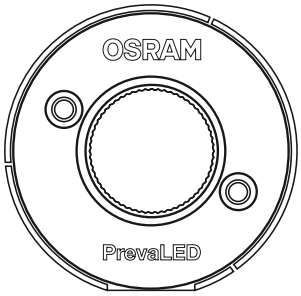
+49 6151 18 01
info-rohmax@evonik.com
www.evonik.com
www.plexiglas.de

Altuglas International

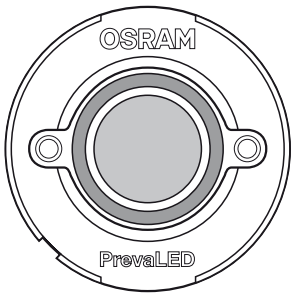
+33 1 78 66 23 00
www.altuglas.com

Sabic Innovative Plastics

+31 164 29 29 11
www.sabic-ip.com



PrevaLED® Core HD



PrevaLED® Core ECO Z2

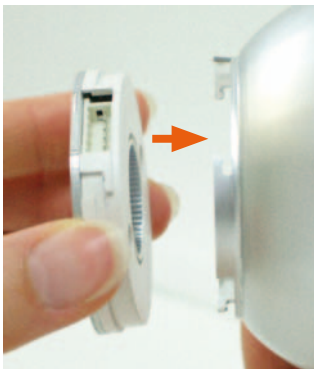
2.1.2. Reflector mounting HD version

PrevaLED® Core light engines offer multiple mounting points for a reflector. For the HD-type light engines, a reflector can be centered on a groove along the outer edge of the light engine as well as in a groove of approximately 23 mm diameter in the center of the light engine. The 800 lm package provides an additional groove of approximately 18.10 mm diameter in the center of the light engine. The inner groove of the light engines allows mounting the reflectors as close as possible to the LED array. Independent of location, all grooves provide a bayonet-type locking mechanism so that a reflector can be fixed to the light engines. The images below show an example of a reflector as it is locked in place, illustrating the location of the mounting grooves.

By using the provided mounting grooves, the requirements of IEC 60598 concerning the light engine level are met. For further details, see the section: *3.1. Safety requirements.*

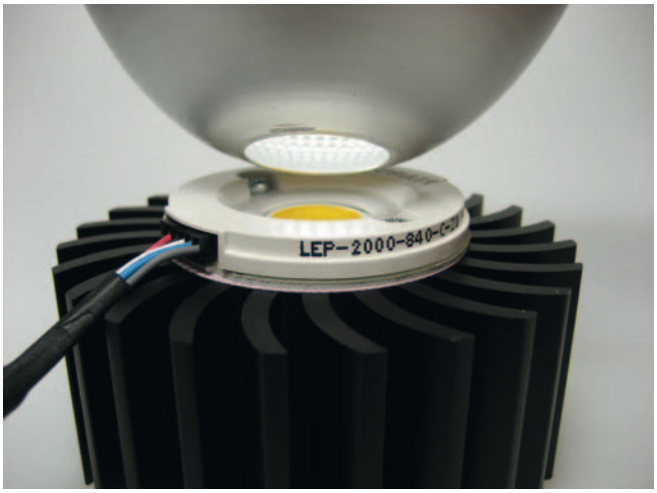
Please note that excessive force on the housing of the light engine when not mounted to a heat sink can damage the light engine or housing. Only connect or disconnect a reflector when the light engine is securely mounted to a heat sink.

The locking mechanism is intended for fixation of the reflector only. Do not apply excessive forces or weight as this may damage the mounting mechanism.



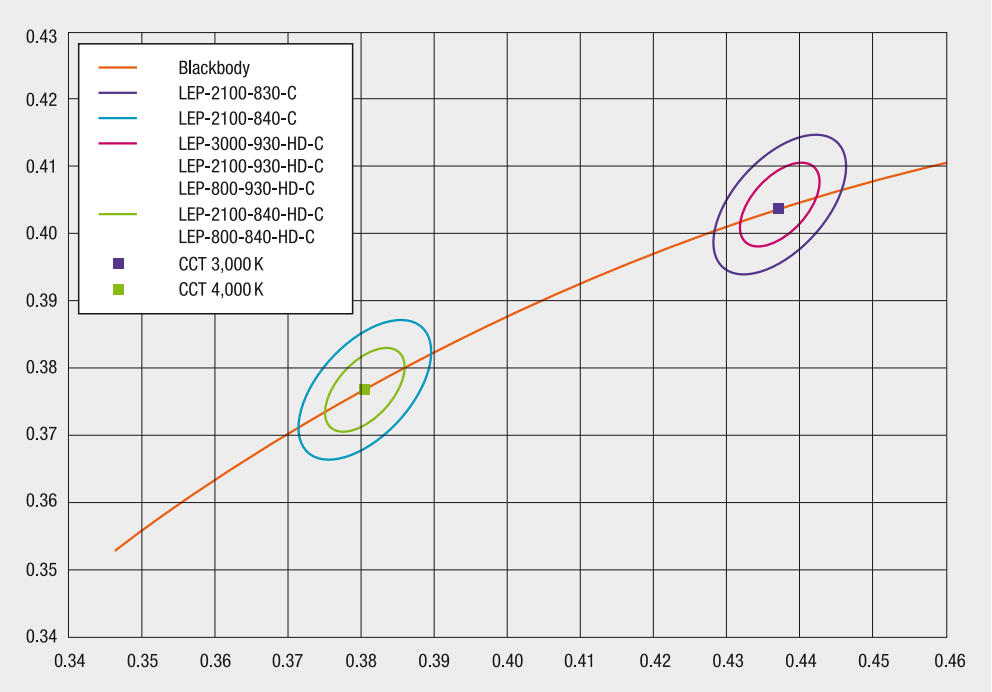
2.1.3. Reflector mounting ECO Z2 version

Z2 ECO light engines employ a different geometry of the housing. These light engines provide a well-defined optical contact area (OCA) that can be used to center and guide a reflector with the light engine. Mounting and mechanical support of the reflector in this configuration must be provided by the luminaire body or through dedicated reflector mounting structures. 3D files of the light engines and design support are available upon request.



2.2. Light color stability

The nominal CCT of the light engine is 2,700 K, 3,000 K, 3,500 or 4,000 K, depending on type of light engine. The light engines provide a module-to-module variation less than 3 (HD) or 4 (ECO Z2) SDCM maximum on Planck around these color targets, depending on type. The higher light color stability for HD types is achieved by active electronic control.



3. Electrical considerations

3.1. Safety requirements

All OPTOTRONIC® OTp devices intended for operating PrevaLED® Core light engines are SELV-equivalent devices with an output voltage of < 120 V_{DC}.

The design of the light engines ensures that the requirements of IEC 60598 are met for the light engine itself. In particular, the LEDs on the light engine need not be covered to fulfill the requirements of IEC 60598.

Due to its construction, the light engine can be mounted directly on an exposed heat sink without further galvanic insulation.

It remains the responsibility of the luminaire manufacturer to provide clearance and creepage distances for the luminaire for an operating voltage of < 120 V_{DC} for the light engines and line voltage where applicable.

3.2. Wiring information

The recommended wire cross section on the primary side of the OPTOTRONIC® OTp ECGs is 0.5–1.5 mm^2. The connection between the OPTOTRONIC® ECG and light engine should be established by using the cable kit available for order in 400 mm and 800 mm length.

The cable material is UL-listed (UL E52653, UL E48762, UL 10368) and fulfills flammability requirements UL 94 V-0 and UL VW-1. The inner wires are approved for 105 °C, the outer cable material for 125 °C.

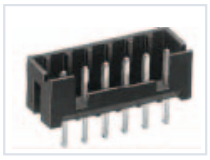
The maximum diameter of the cable is 5 mm, additional details on the dimensions of the cable kit are given in the illustrations on the right page.

For support on customizing cable lengths or construction, you can use the manual cramping tool from Hirose Electric or contact your sales partner.

The cable for PrevaLED® Core ECO Z2 has two different connectors and shows a white ring at the light engine side of the cable (to be confirmed).

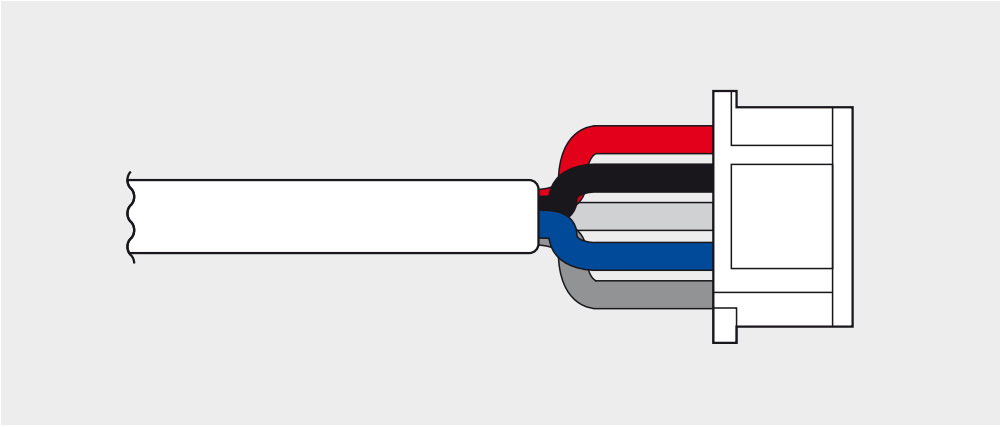
Components of the connection cable between LEP and OTp

5-pole plug (crimping socket**)*
DF3-5S-2C



Terminal (straight pin header)
DF3A-5P-2DSA

*) The picture shows the crimped status of the contact.
**) The crimping socket is produced by Hirose Electric: www.hirose.com



Pin 1	LED+
Pin 2	LED-
Pin 3	Aux. voltage
Pin 4	Sense comm.
Pin 5	Aux. gnd.

PIN assignment of connector

3.3. Wiring in class I and class II luminaires

Depending on the design of the luminaire according to class I or class II requirements, a protective earth connection can be established for the OPTOTRONIC® ECG.

For class II luminaires standards can be fulfilled using a cable clamp. The functional earth may be connected to the ECG to improve the EMI behavior.

See illustrations below for these requirements.

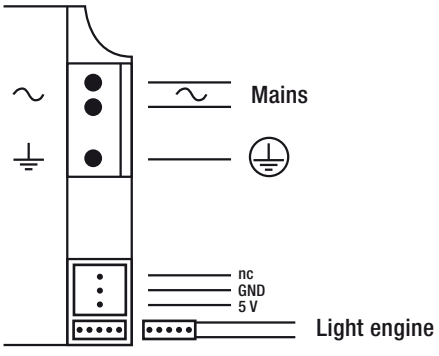
As the power supplies are SELV-equivalent, no additional galvanic insulation has to be provided for the light engine.

3.4. Optional cable clamp

For OPTOTRONIC® OTp 35 and OTp 45 types, an optional cable clamp is available for order. This cable clamp can be snapped onto the ECG and thus converts it into an ECG suitable for independent installation with strain relief.

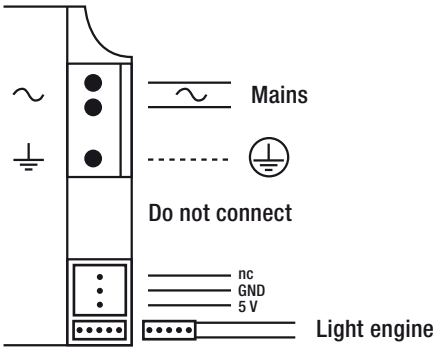
When using this cable clamp, luminaire design according to IEC 60598-1 class I and class II is possible. Connection of protective earth as detailed above must be observed.

Please also note the installation requirements as supplied with the cable clamp.



Class I connection

Earth connection is mandatory in class I luminaires and improves EMI compliance according EN 55015.

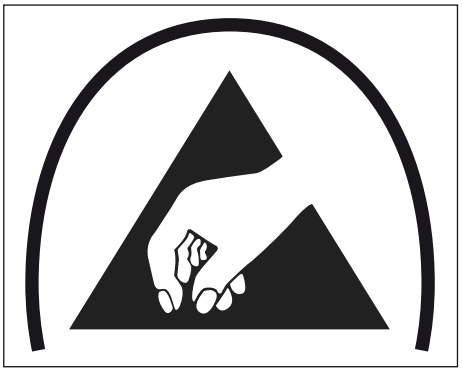


Class II connection

In class II luminaires do not connect earthing terminal.

3.5. ESD protection of light engines

PrevaLED® light engines require special ESD-safe handling procedures in a production environment. Please refer to the datasheet for specific recommendations.



3.6. Ingress protection

PrevaLED® Core light engines and matching OPTOTRONIC® OTp devices are intended for use in dry locations.

For operation in damp/wet or dusty environments, the luminaire manufacturer must ensure suitable installation and protection of light engines and ECG.

You can use up to 15 OTp (35/45) on one 16-A circuit breaker.

4. Thermal considerations

Proper thermal design of an LED luminaire is critical for achieving best performance and ensuring long lifetime of all components. While PrevaLED® Core light engines operate with minimal thermal losses possible, a substantial amount of the light engine power as specified (please refer to: *1.2.2. Technical data*) must be dissipated through the backside of the light engine.

Depending on the application and the light engine chosen, passive cooling can be achieved. In critical applications (e. g. small available heat sink size in combination with high-power light engines), active cooling may be needed. Active cooling combines a heat sink with a fan or a similar device to maximize the cooling power out of a given heat sink.

4.1. Thermal interface material and other accessories

When mounting PrevaLED® Core within a luminaire it is highly recommended to use thermal interface material between the light engine's backside and the luminaire housing. Either paste or foil can be used. The material has to be as thin as possible and should meet the desired conduction between the light engine surface and the luminaire housing surface. For this purpose, the planarity and roughness of the surface should be optimized. Pads made of Kerafol material with a diameter of 50 mm and with appropriate mounting holes can be ordered through the Alfatec company: *www.alfatec.de*.

The lists below show a selection of suppliers of different cooling solutions and thermal accessories. The light engine system has been tested, for example, with coolers from Nuventix (SynJet® Spotlight Cooler 38W) and Sunon (Spot-Light Cooling system: TA004-10003).

Active cooling systems:	
Nuventix	www.nuventix.com
Sunon	www.sunoneurope.com
Cooler Master	www.coolermaster.com
AVC	www.avc-cooling.com
Heat sinks:	
Fischer Elektronik	www.fischerelektronik.de
Pinbloc	www.pinbloc.de
Aavid Thermalloy	www.aavidthermalloy.com
Meccal	www.meccal.com
Wakefield	www.wakefield.com
R-Theta	www.r-theta.com
Cool Innovations	www.coolinnovations.com
Radian	www.radianheatsinks.com

Thermal interface materials:	
Laird	www.lairdtech.com
Kunze Folien	www.heatmanagement.com
Aavid Thermalloy	www.aavidthermalloy.com
Chomerics	www.chomerics.com
Bergquist	www.bergquistcompany.com
Wakefield	www.wakefield.com
Arctic Silver	www.arcticsilver.com
Dow Corning	www.dowcorning.com
Thermagon	www.thermagon.com
Kester	www.kester.com
Thermaflo	www.thermaflo.com
MG Chemicals	www.mgchemicals.com
Electrolube	www.electrolube.com
Kerafol	www.kerafol.de

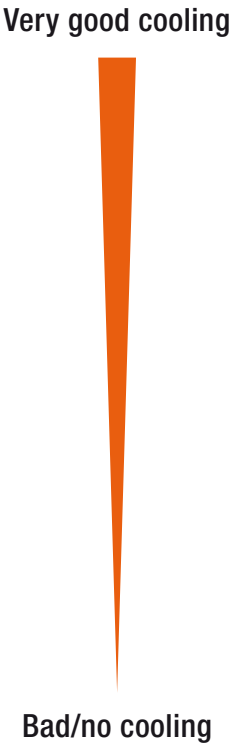
Heat pipes:	
DAU	www.dau-at.com
MB Electronic AG	www.mb-electronic.de
Simulation software:	
SolidWorks	www.solidworks.com
Flotherm	www.mentor.com
Comsol	www.comsol.de
Thermal probes:	
OMEGA	www.omega.de
B+B Thermo-Technik	www.bubthermo.de

Additional partners for thermal support can also be found at OSRAM's LED Light For You network: *www.ledlightforyou.com*.

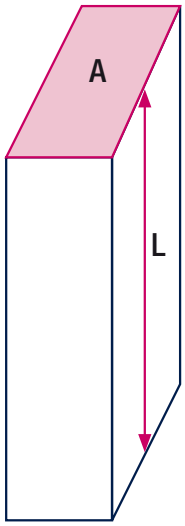
4.2. Heat sink size

For the selection of a suitable heat sink, several considerations regarding thermal resistance have to be made. Below, you can find the definition of the thermal resistance concerning the direct conduction through solid material:

Material	λ [W/(m · K)]
Copper	380–401
Aluminium	200–220
Brass	120
Steel	42–58
Stainless steel	15
Glass	1
Wood	0.13–0.18
Air (dry at 1,013 mbar, no convection)	0.0256 at 20 °C



$$R_{thcond} = \frac{L}{A_{cross} \cdot \lambda}$$

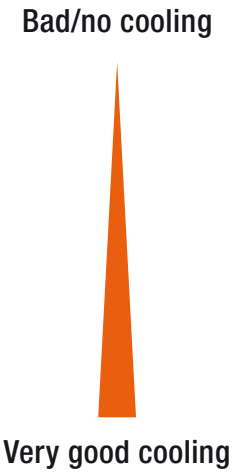


λ: Spec. heat conductance value *[W/(m · K)]*
L: Length through the material in flow direction *[m]*
A: Material cross section/surface of the heat sink *[m²]*

For satisfying heat transfer and good cooling, the surface of the used heat sink material also has to be taken into consideration. Depending on the location of the particular application, it could be an advantage to use black anodized heat sinks to get the best heat transfer to the ambient air. Within applications with high surrounding heat radiation, it would on the other hand be an advantage to have a high reflective material to avoid collecting additional heat from the environment.

Within common applications such as normal downlight applications within recessed ceilings, a black anodized heat sink would be sufficient. Below, you find an overview of some materials with different surfaces:

Material	Emission ratio ϵ	Temperature * [°C]
Gold, polished	0.018	130
Aluminium plate, rolled, blank	0.040	170
	0.022	25
Aluminium, black anodized	0.600	40
Aluminium, lacquered, matt black	0.970	80



** Temperature of the material at which the emission ratio was measured*

For the optimization of the radiation, special lacquers with a high emission ratio, which are typically used for radiators, are available on the market.

To give a short guideline for the selection of a suitable heat sink, the following steps are generally necessary:

Define boundary conditions

Total power dissipation of the light engine
Max. ambient temperature T_{amb}
Max. reference temperature T_c according to lifetime requirements

Estimate heat sink thermal resistance on light engine level

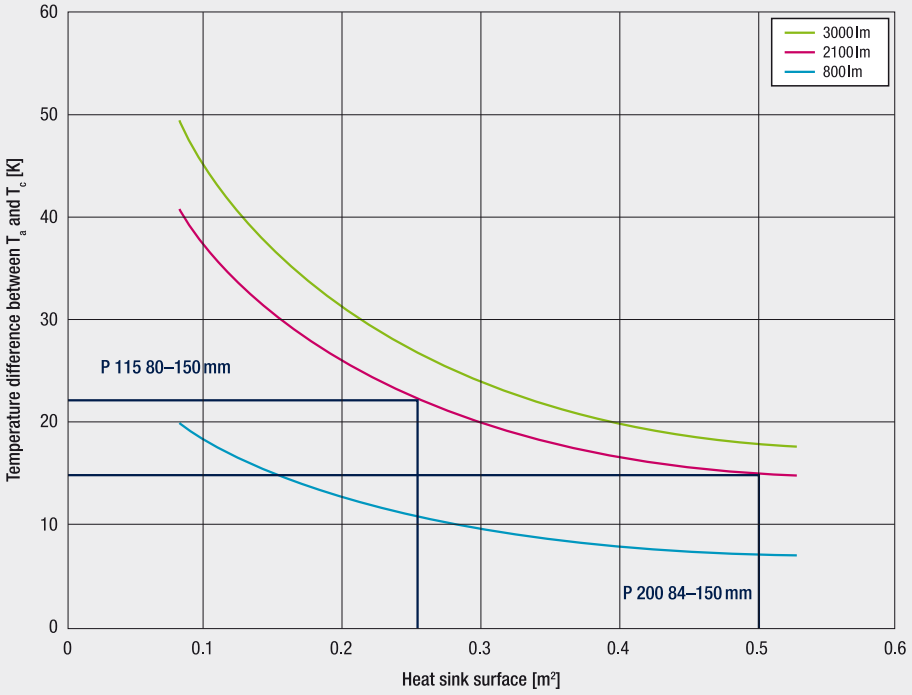
$$R_{thCA} = \frac{T_C - T_A}{P_{Light\ engine}}$$

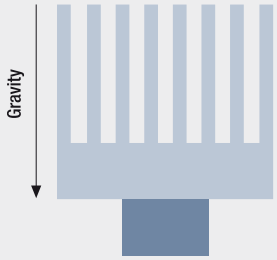
Select heat sink thermal resistance

Use the estimated R_{thCA} as a target for a possible heat sink profile and examine the performance curve in the supplier catalog.

Check the design with thermal measurements as soon as physical prototypes are available.

Heat sink estimation depending on ambient conditions





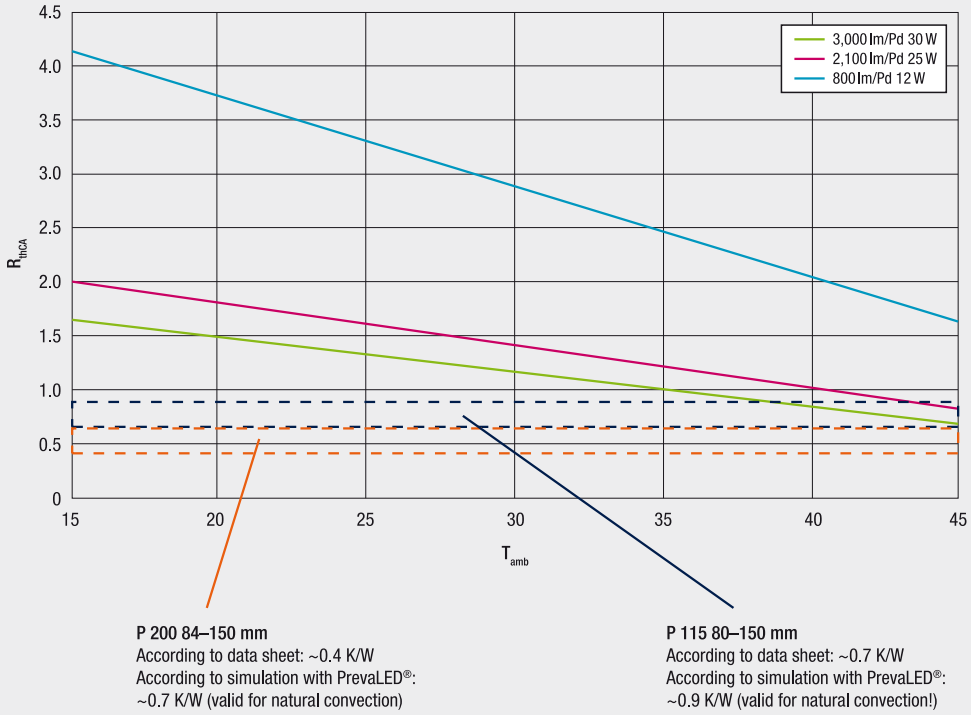
PrevaLED® Core on extruded-profile heat sink in downlight orientation

The diagram above can be used to estimate the cooling performance of a given heat sink size or determine the approximate size of heat sink required for given ambient temperatures. Simulations were done without any airflow turbulences, just within free convection.

As an example for heat sinks with 0.25 m² and 0.5 m², the diagram indicates that a delta of approximately 22 °C or 14 °C respectively can be expected for the LEP-2100 light engines' T_c point as compared to the ambient temperature. The simulations on the next page highlight this result.

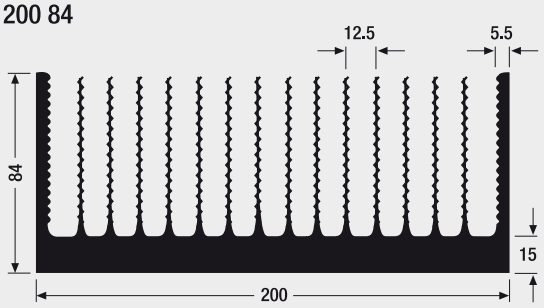
In reverse direction, given the maximum T_c temperature of 65 °C of the light engines and an ambient temperature of 45 °C, the resulting temperature difference of 20 degrees can be used to find the approximate needed heat sink size for stable operation. For the given temperatures and an LEP-2100 light engine, this is a heat sink with a surface of approximately 0.3 m².

Note: The estimations on these two pages are for illustration only. In any case, the realized application has to be tested by a T_c measurement.

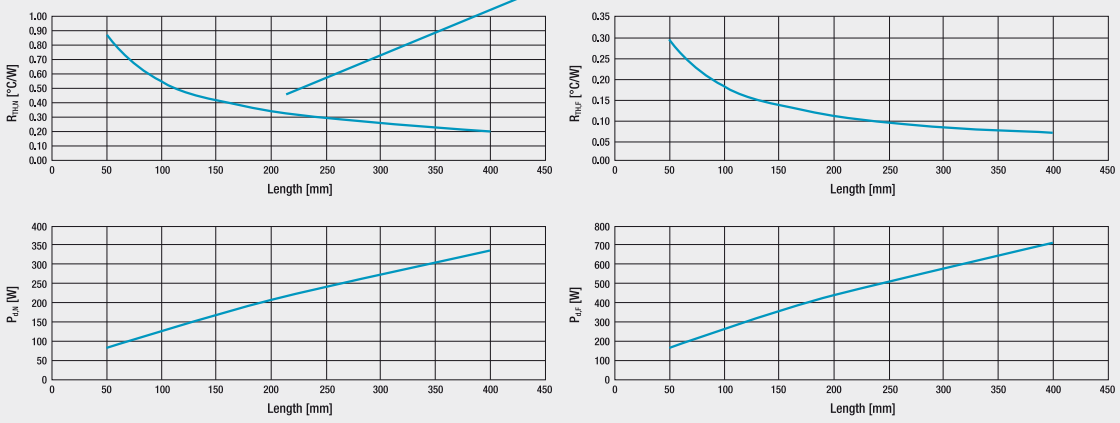


This diagram shows the correlation between a given ambient temperature and the resulting R_{thCA} for T_c max. for the different light engines. The two Meccal extrusion profiles are also marked in the diagram. From these data, one can estimate the heat sink R_{thCA} for different ambient temperatures.

P 200 84



Heat sink	P 200 84
Length [mm]	200
Weight [kg/m]	17.70
$R_{TH,N}$ [°C/W]	0.34
$P_{d,N}$ [W]	205
$R_{TH,F}$ [°C/W]	0.113
$P_{d,F}$ [W]	440



Note: The estimations on these two pages are for illustration only. In any case, the realized application has to be tested by a T_c measurement.

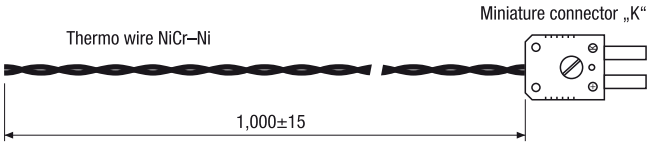
4.3. T_c measurement

After mounting the light engine in the luminaire, the T_c temperature (case temperature) has to be measured within the planned ambient and operation conditions.

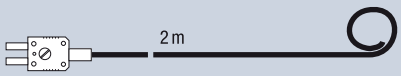
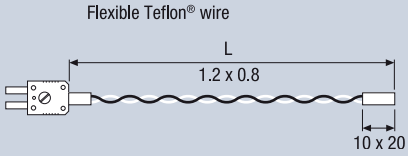
Therefore, a thermal probe has to be fixed at the T_c point, either by gluing, soldering or welding. Examples of recommended thermal couples are shown below.

With this Tc, you can determine your heat sink solution:

$$R_{th}\ heat\ sink = \frac{(T_c - T_a)}{Thermal\ power\ (PrevaLED^{®}\ light\ engine)}$$

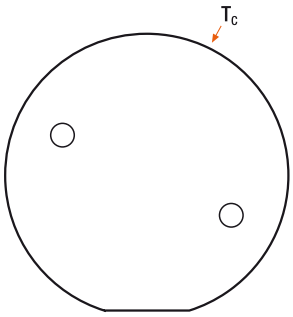


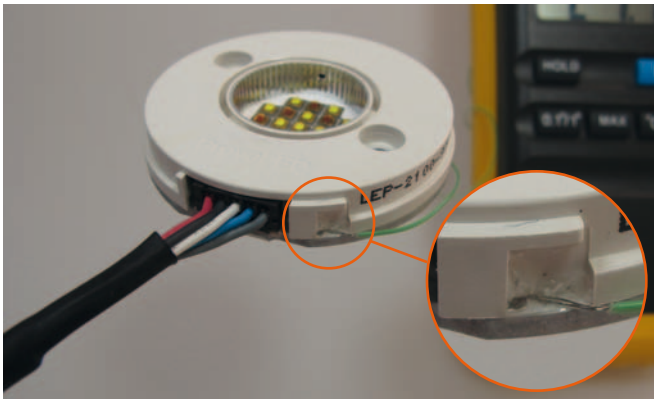
K-type thermocouple with miniature connector

	Description	Temperature [°C]	Length [mm]	T90
	Thermal probe	-10…+100	2,000 cable	20
	Adhesive foil probe	-50…+250	1,000 wire	12

All figures in mm

PrevaLED® Core HD

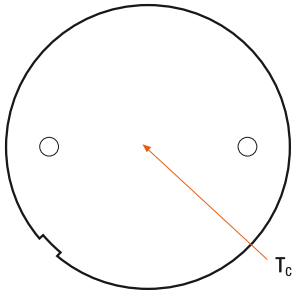


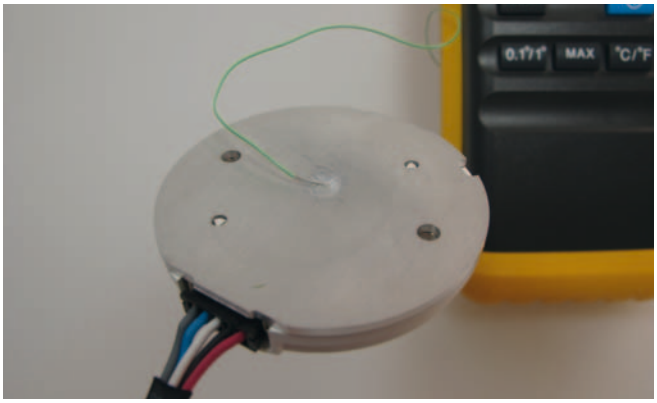


*T_c is measured **on the side** of the light engine*

Please measure the case temperature (T_c) for PrevaLED® Core HD **on the side** of the light engine. This can be achieved by gluing the tip of the thermal couple right from above on the PCB within the recess as shown on the picture.

PrevaLED® Core ECO Z2





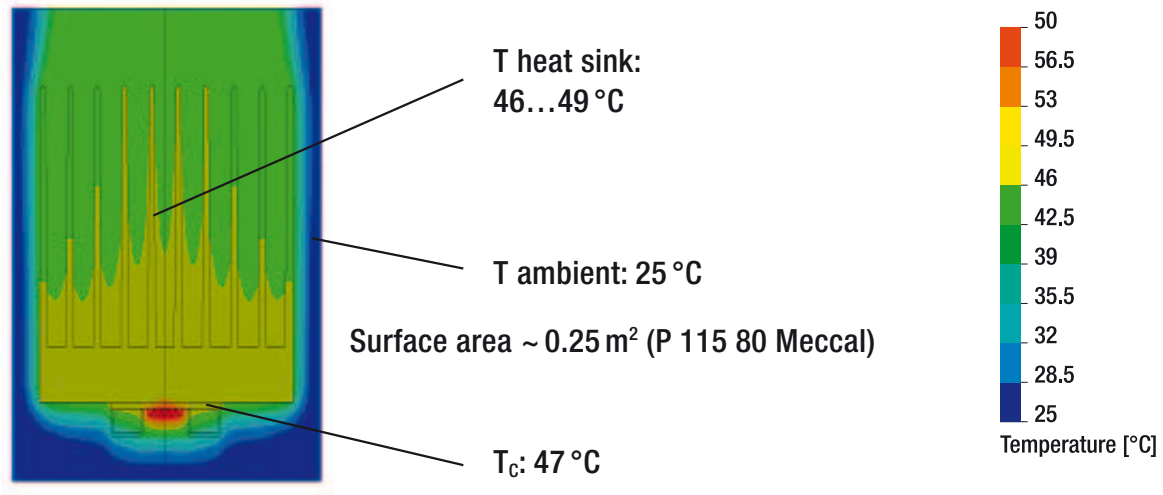
*T_c is measured **in the center of the back side** of the light engine*

Please measure the case temperature (T_c) for PrevaLED® Core ECO Z2 **in the center of the back side** of the light engine. This can be achieved by a thin, milled channel or a drilled hole.

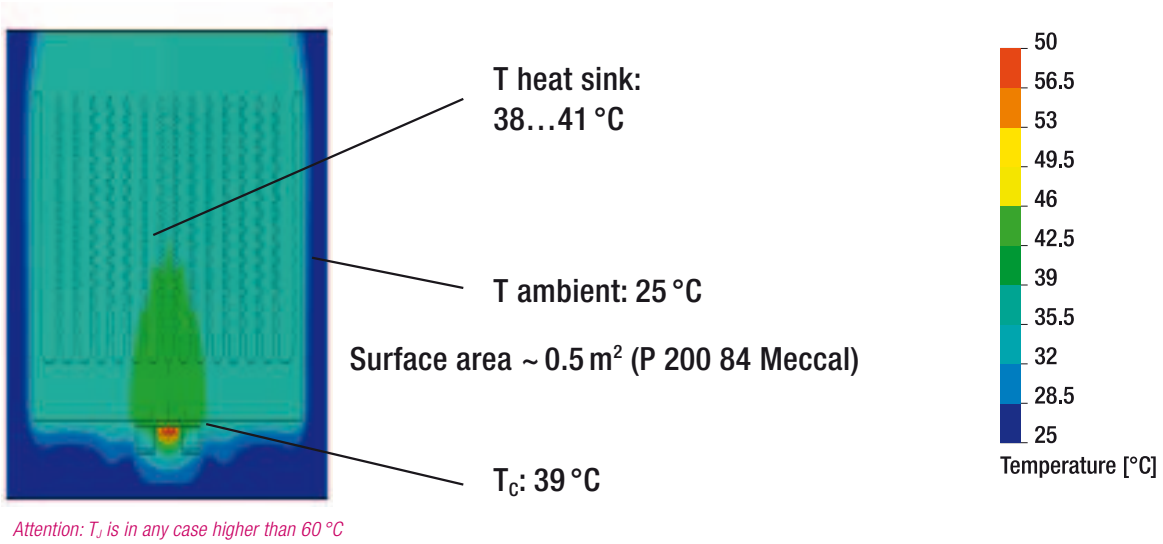
Both methods of measurement on the specific light engines will assure a precise thermal interface within the thermal path from the heat source to the ambient air.

4.4. Thermal simulation

Two examples of heat sink simulations:



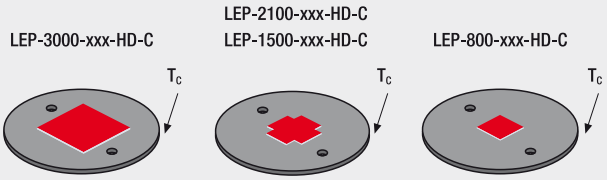
Attention: T_J is in any case higher than 60 °C



Attention: T_J is in any case higher than 60 °C

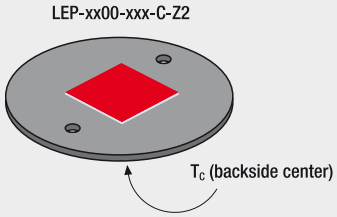
PrevaLED® LEP-2100 on extruded-profile heat sink – 150 mm in downlight orientation

Thermal model description: PrevaLED® Core HD



1. Apply light engine power on red surface
2. Apply properties of thermal interface material (TIM) on bottom face
3. Apply thermal conductivity of Al5052 (137 W/m*K)
4. Run simulation
5. Read out T_c temperature on rim
6. Verify simulation results on prototype

Thermal model description: PrevaLED® Core ECO Z2



1. Apply light engine power on red surface
2. Apply properties of thermal interface material (TIM) on bottom face
3. Apply thermal conductivity of Al5052 (137 W/m*K)
4. Run simulation
5. Read out T_c temperature on backside center
6. Verify simulation results on prototype

Step-files for thermal simulation are available on *www.osram.com/prevaled-core*.

4.5. ECG thermal considerations

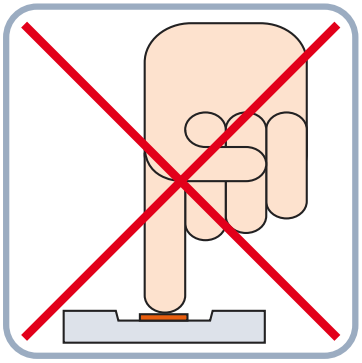
The installation of the ECG must ensure that the maximum temperature at the T_c is not exceeded. Further details on thermal considerations for OPTOTRONIC® devices can be found in the technical guide for OPTOTRONIC®, available at *www.osram.com/optotronic*.

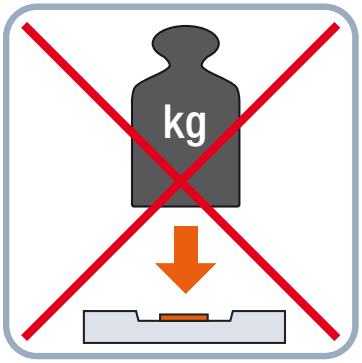
5. Mechanical considerations

5.1. Light engine dimensions

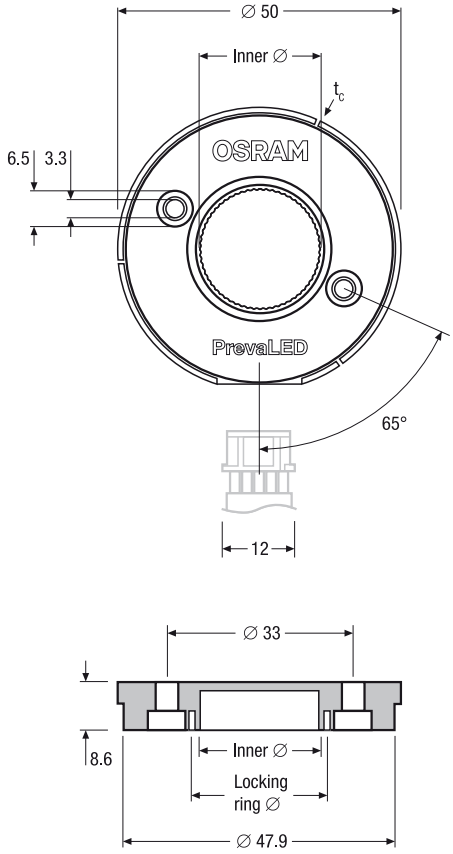
The illustrations below provide futher details on the dimensions of the available PrevaLED® Core light engines. 3D files are available on our website: *www.osram.com/prevaled-core*.

Please apply no pressure on LED/LES (light-emitting surface). Handle with care!



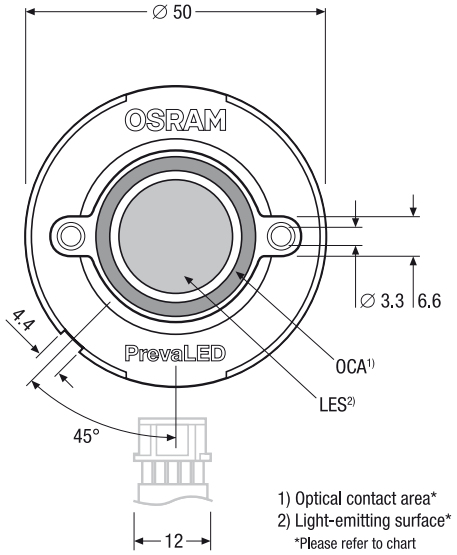


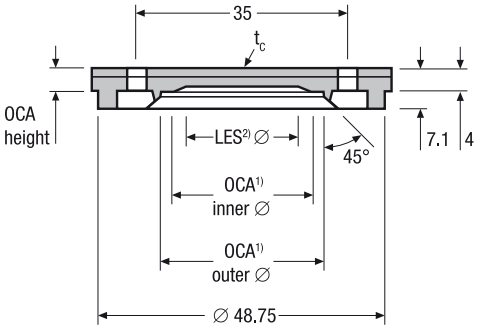
PrevaLED® Core HD



All figures in mm (except where noted otherwise)

PrevaLED® Core ECO Z2

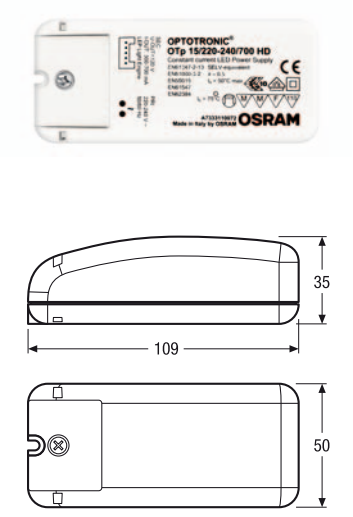




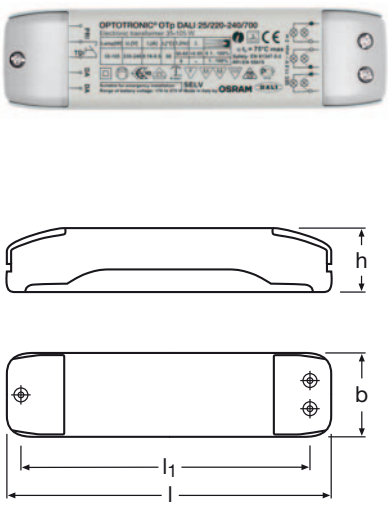
	PrevaLED®							
	Core HD		ECO Z2					
Lumen stacks [lm]	Inner ∅ [mm]	Locking ring ∅ [mm]	LES		OCA			
			Category	∅ [mm]	Category	Inner ∅ [mm]	Outer ∅ [mm]	Height [mm]
3000	21	24	cat. LES23	22	D	26	28.5	4
2000 (2100 for Core HD)			cat. LES19	15.75	B	19		
1500								
800	16.3	19.15	cat. LES9	8.6	A	13.5		

5.2. ECG dimensions

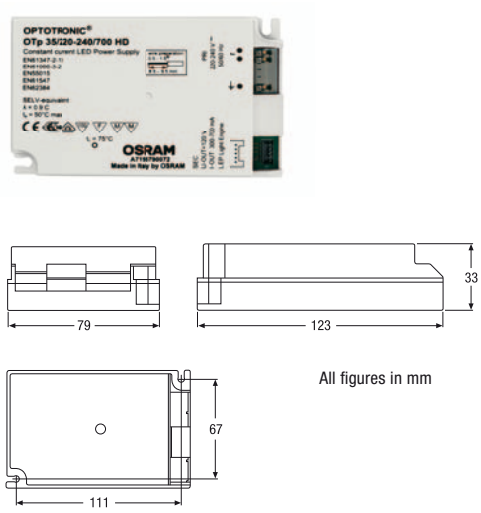
ECG dimensions are also given in the section: *1.2.2. Technical data.*



OTp 15



OTp DALI 25



All figures in mm

All OTp 35 and OTp 45 types

Detailed mechanical drawings and 3D files are available on our website.

- Housing material of these devices is PBT and complies with UL 94 V-0.
- For input wiring, the housing provides push-in terminals.
- It is recommended to use washers when mounting the ECGs to the luminaire.

5.3. Light engine mounting

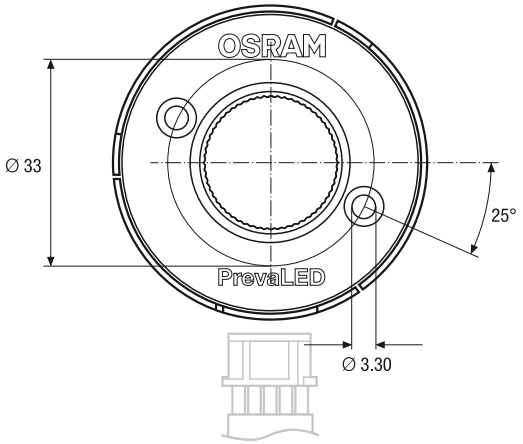
PrevaLED® Core light engines are mounted to a heat sink with two M3 screws through the mounting holes within the light engine. The mounting holes are reinforced with metal bushing, providing additional strength for a reliable and thermally high-performing connection.

Depending on the thermal interface material and contact surface conditions, the necessary screwing torque can vary. Good experiences were made with a range of 0.4 to 0.8 Nm, higher torque levels do not necessarily lead to significantly better heat transfer to the heat sink, but may lead to damage of the light engine.

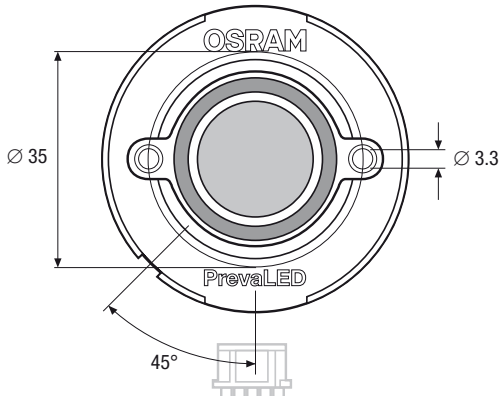
The recommended counter sink diameter of the mounting holes for good thermal performance is 3.5 mm maximum. A bigger counter sink can lead to mechanical deformation of the PCB and a reduction of heat transfer into the heat sink. When mounting the light engine with self-cutting screws, an additional torque may be needed to prepare the thread.

In reference designs, good mounting results were achieved with EJOT ALTracs.

Due to a large number of possible combinations of thermal interface material, heat sinks and screws above recommendation should be carefully checked for each individual design to maximize heat transfer between the light engine and the heat sink. Optimal mounting can lead to a lower operating temperature of the light engine and to an improved performance of the system.



PrevaLED® Core HD



PrevaLED® Core ECO Z2

All figures in mm (except where noted otherwise)

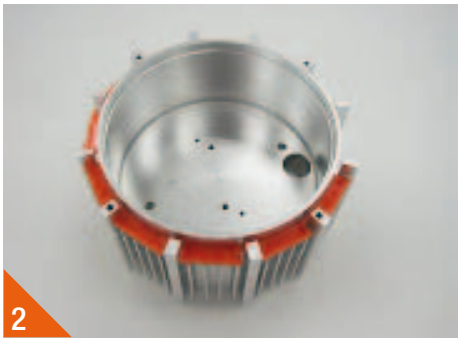
6. Fixation in a luminaire (example)

To get a better understanding of the light engine concept and the design of a luminaire, the following pages will lead through an exemplary mounting into a demonstrator using the 800 lm light engine PrevaLED®.

On the first picture, you can see the different components of the complete system:

- Housing (acts as heat sink)
- Reflector
- Cover
- Decorative ring
- Mounting ring
- Main connection wire
- Cable kit
- Thermal interface material
- Light engine

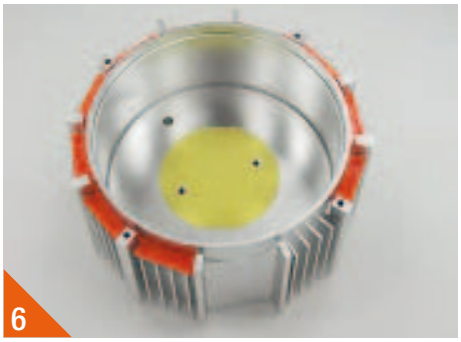
As a first step, the thermal interface material has to be applied within the light fixture housing and/or heat sink.



6.1. Preparation

After applying the thermal interface material, the light engine has to be fixed to the surface. For mounting instructions and screw selection, please see the instruction in chapter: *5.3. Light engine mounting.*

To ease the centering of the light engine, small plastic sticks or pins can be inserted into the screw holes in the heat sink to guide the light engine into the right place. After centering, the guiding pins can be removed and substituted by the screws.

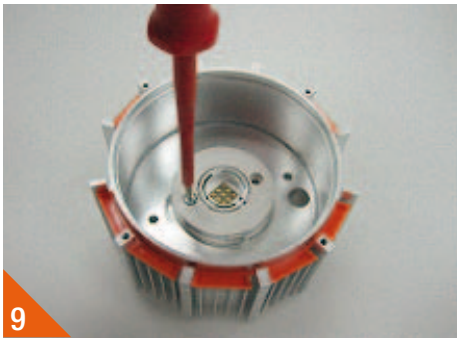


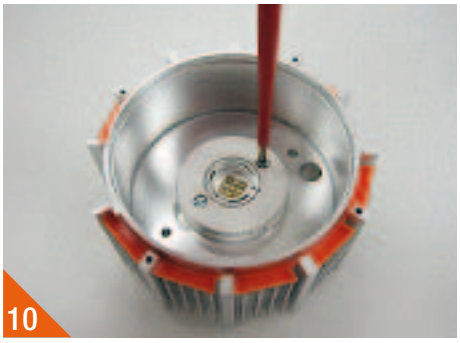
6.2. Wiring and reflector/cover

To connect the light engine to the power supply, the suitable cable kit should be used. To get the connector easily into the housing, a through hole with a minimum diameter of 10 mm is suggested.

Once the light engine is connected, the reflector can be attached to the housing and the diffuse cover can be placed on top of the luminaire.

Both components have to be properly centered above the light engine.





6.3. Commissioning PrevaLED®

After the fixation of the mounting ring, the optional decorative ring can be put into place.

As an example for an electrical connection within a class-II installation, the two wires for the main connection have to be applied to the OPTOTRONIC® power supply.

In a class-I installation, the protective earth has to be connected in addition.

Finally, the complete system can be connected to the mains and powered up.

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7. Norms and standards

7.1. Standards for PrevaLED®

PrevaLED® complies with the following standards:

LED modules safety:	IEC 62031 DIN EN 62031
Connectors for LED modules:	IEC 60838-2-2
Photobiological safety:	EN 62471:2008 (CIE S009): Depending on type
Electromagnetic compatibility:	DIN EN 55015 DIN EN 61547 DIN EN 61000-3-2 DIN EN 61000-3-3
Ingress protection:	IP 20
Vibration, shocks, tensile strength:	IEC 60068-2-6 IEC 60068-2-27 IEC 60068-2-21

7.2. Power supply standards and features applicable to PrevaLED®

Safety:	IEC 61347-1, IEC 61347-2-13
Performance:	IEC 62384
Radio interference:	EN 55015 (A1: 2007)
Harmonic content:	IEC 61000-3-2
Immunity:	IEC 61547
Temperature range:	See corresponding value within the datasheet
Galvanic insulation between primary and secondary side:	3 kV_{rms}
No-load proof:	Yes
Short circuit proof:	Yes
Overload protection:	Automatic shutoff, reversible
Overheating protection:	Automatic shutoff, reversible
Connection, primary:	For OTp 15 HD: screw-terminals For OTp 35 HD and OTp 45 HD: push-in terminals
Cross section, primary:	0.5 mm^2 – 1.5 mm^2
Connection, secondary:	5-pin connector, for use with cable kit
Cross section, secondary:	For use with cable kit
Dimensions (L x W x H):	123 x 79 x 33 mm for all OTp 35 and all OTp 45 109 x 50 x 35 mm for OTp 15 HD
Approvals:	

7.3. Interchangeability of LED light engines

The Zhaga Consortium (consortium for the standardization of LED light engines) aims to make the LED light sources ("LED light engines") manufactured by different companies interchangeable. Zhaga is a global cooperation with participation by luminaire manufacturers, lamp manufacturers, LED module makers, and companies that supply the lighting industry. Interchangeability of LED light engines is achieved by specifying the interfaces for a variety of application-specific light engines. Zhaga interface specifications cover the physical dimensions, as well as the photometric, electrical and thermal behavior of each LED light engine.
The Zhaga consortium was established in February 2010. More than 100 companies have joined the Zhaga Consortium. The members meet every 6–9 weeks in Asia, the USA, or Europe. In June 2011, the Zhaga Consortium approved the second light engine specification. This is the specification for the interfaces of a spotlight engine.

7.4. Photobiological safety

PrevaLED® light engines were tested regarding the risk group definition within EN 62471: 2008. According to this standard, the following tables show the risk group definitions and test results of the different light engines.

All PrevaLED® Core light engines (with and without PreMix) have to be classified according to EN 62471-1 in risk group 1 (RG 1). In RG 1, in absence of UV and IR radiation, no labeling is required (TR 62471-2).

LEP-3000 3,000 K

Spectral radiance and local BLH radiance see below.

Maximum permissible BLH dose (EN 62471)	1 MJ/(m²sr)
Maximum blue light effective radiance in a field of view corresponding to 1.7 mrad	
BLH (1.7 mrad)	28,169 W/(m²sr)
Maximum exposure time	36 s

The maximum exposure time related to 1.7 mrad is larger than 10 s. Therefore, the risk group classification may be determined using a field of view related to 11 mrad.

Maximum blue light effective radiance in a field of view corresponding to 11 mrad	
BLH (11 mrad)	8,502 W/(m²sr)
Maximum exposure time	118 s
Risk group classification	**RG 1**

LEP-3000 4,000 K

Spectral radiance and local BLH radiance see below.

Maximum permissible BLH dose (EN 62471)	1 MJ/(m²sr)
Maximum blue light effective radiance in a field of view corresponding to 1.7 mrad	
BLH (1.7 mrad)	49,583 W/(m²sr)
Maximum exposure time	20 s

The maximum exposure time related to 1.7 mrad is larger than 10 s. Therefore, the risk group classification may be determined using a field of view related to 11 mrad.

Maximum blue light effective radiance in a field of view corresponding to 11 mrad	
BLH (11 mrad)	12,870 W/(m²sr)
Maximum exposure time	78 s
Risk group classification	**RG 1**

LEP-2100 3,000 K

Spectral radiance and local BLH radiance see below.

Maximum permissible BLH dose (EN 62471)	1 MJ/(m²sr)
Maximum blue light effective radiance in a field of view corresponding to 1.7 mrad	
BLH (1.7 mrad)	14,412 W/(m²sr)
Maximum exposure time	69 s

The maximum exposure time related to 1.7 mrad is larger than 10 s. Therefore, the risk group classification may be determined using a field of view related to 11 mrad.

Maximum blue light effective radiance in a field of view corresponding to 11 mrad	
BLH (11 mrad)	3,855 W/(m²sr)
Maximum exposure time	259 s
Risk group classification	**RG 1**

Global presence.

OSRAM supplies customers in 148 countries.
- 85 companies and sales offices for 122 countries
- 26 countries served by local agents or OSRAM GmbH, Munich

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Austria
Belarus
Bosnia-Herzegovina
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Denmark
Ecuador
Egypt
Estonia
Finland
France
Georgia
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